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FARMERS' BULLETIN 1256
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SLASH PINE



SLASH PINE grows rapidly and yields revenue in turpentine gum at an early age while it is growing timber.

Farmers and other owners of cut-over pine lands in the Gulf region are deriving a good profit from poorly drained, "barren" lands by utilizing them for the grazing of live stock and the production of turpentine and timber.

Well-stocked stands of slash pine produce timber for ordinary purposes in 30 years, at the rate of 100 to 250 board feet an acre a year on average poor-quality land, and on average good situations at the rate of 300 to 500 board feet yearly.

Slash pine can be profitably grown in the South on poor and wet lands.

There are millions of acres in unimproved parts of farms and in cut-over lands that are profitless for agriculture but suitable for the production of timber and naval stores.

By proper methods of cutting and protection, southern pine forests can be perpetually renewed and kept continuously productive.

Young pine is valuable.

Contribution from the Forest Service

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Washington, D. C.

May, 1922

The picture on the front cover is second-growth slash pine in southern Georgia being worked for turpentine

Have later ed.

SLASH PINE.

WILBUR R. MATTOON, *Forest Examiner.*

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SLASH PINE is one of the most profitable timber trees of the South Atlantic and the Gulf States. The old growth, which is being extensively cut, is sold without discrimination along with long-leaf pine. Second-growth slash pine, following the cutting of the original forest, has spread rapidly over large areas of flatlands and low uplands of the region. It has been particularly aggressive in establishing itself on old fields and other idle or waste lands about farms and towns. A reliable lumber authority recently estimated that probably not less than 90 per cent of the total amount of sap-pine cut for railroad ties in southern Georgia and northern Florida consists of this species.

Slash pine grows rapidly and at an early age produces turpentine and rosin, as well as timber of high commercial value. Its wood is the heaviest, hardest, and strongest of all pines of the United States, and its yield of crude turpentine is the largest of any of our native trees. Thus slash pine has come to be important in the young or second-growth forests of the South Atlantic and Gulf Coastal Plain because of its good seed production, rapid growth, and ability to grow in dense stands on poorly drained soils. In the economic development now well under way in the South, slash pine is already playing no small part in bringing nonagricultural lands into their most profitable use.

HOW TO RECOGNIZE SLASH PINE.¹

Slash or "yellow slash" pine was formerly referred to in forestry literature as Cuban pine. In South Carolina and Georgia the original-growth slash pine is sometimes called "rosemary," a name



FIG. 1.—Light orange-colored plates in the bark of mature trees serve to distinguish slash pine from all others. The turpentine workers, though unfamiliar with the botanical features, unmistakably identify this pine by its bark, which they associate with the free-flowing resin qualities of the tree.

applied, however, in different sections to large trees of several other species of pines. In its younger stages on abandoned fields it is somewhat widely known as "oldfield," and even as "shortleaf" pine.

Because of the general resemblance of young slash pine to loblolly pine and of the mature slash pine to longleaf pine, considerable difficulty is experienced by persons unfamiliar with the southern pine forest in differentiating the species. However, slash pine is not difficult to identify if one possesses the essential information regarding the foliage, cones (burrs), and bark.

The bark is irregularly divided into thin, dark red-brown scales. Young trees have thicker bark than old ones. The bark of the mature tree has orange-colored scales (fig. 1, and back cover).

The cones are egg-shaped and average 3 to 5 inches in length and, when closed, about 2 inches in width. A small prickle is borne on the lustrous or varnished brown end of the cone scale. (Fig. 2.)

¹ The botanical name is *Pinus caribaea* Morelet. The name formerly accepted was *Pinus heterophylla* Sudworth.

In the lower Florida Peninsula and close along the coasts somewhat north, a form of slash pine grows which by some botanists is believed to be a distinct species called *Pinus cubensis* Griseb. The tree grows on well-drained upland soil and produces gum in less quantity than the more northern form.

The leaves grow in clusters or bundles of 2 and 3, usually with more of the 2-leaved clusters. They are stout and mostly 8 to 12 inches long, and the color is dark, rich green. (Fig. 2.)

The terminal bud is large, reddish brown in color, and in the spring elongates into a straight, stout, light-gray "candle" about the thickness of a large pencil. Longleaf pine, in distinction, has a similar but larger bud elongating into a light-gray "candle," an inch or over in diameter.

The leaf of slash pine is intermediate in length between that of loblolly and longleaf and darker green than either. Both loblolly and longleaf bear foliage with 3 leaves in a cluster. The foliage of slash pine is more dense than that of longleaf and, in the Gulf region, than that of loblolly, which is of a bluish or grayish cast. (Fig. 3.) The cone averages larger than that of loblolly and smaller than longleaf.

The main characteristics by which slash pine is identified are the orange-colored bark plates on the mature tree; the 2 and 3 leaf cluster of heavy, dark-green foliage; the slender prickles on the cone, pointing straight or slightly curved upward on the lustrous-brown end of the cone scale; and the early spring "candle" or shoot, of slash pine, which is light gray, erect, and about one-half inch in diameter.²

Mature trees, or "old growth," of slash pine rise to heights of 80 to 150 feet, with clear lengths of 40 to 70 feet. Diameters of trunks range from 2 to 3 feet, measured at breastheight, or $4\frac{1}{2}$ feet from the

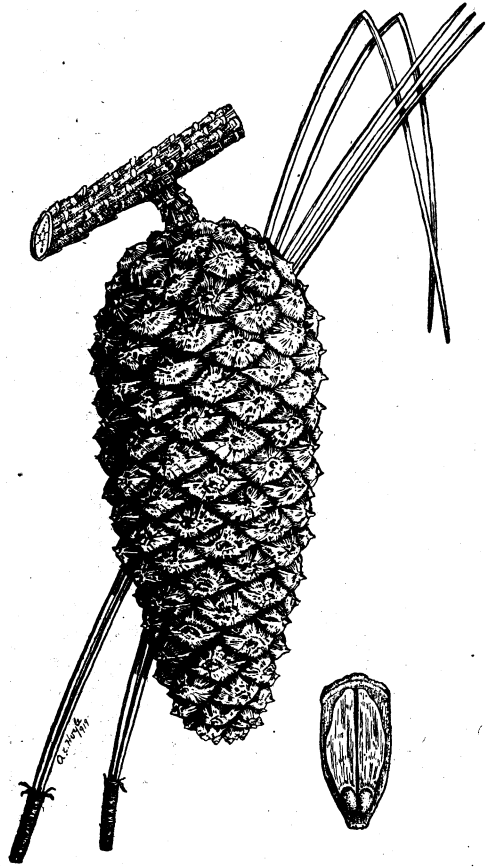


FIG. 2.—Cone or "burr," two leaf clusters, and a cone scale of slash pine. The ends of the cone scales are plump, rounded, lustrous brown, and bear a small prickle. At the base of each scale two seeds are borne, each with an ample wing for wide dispersal. Leaf bundles of slash pine contain either two leaves or three leaves in a cluster.

² The spring shoot of loblolly is grayish green, slender, and often curved or drooping instead of erect.

ground.³ The trunk is straight and commonly has more basal swell than longleaf pine.

The numerous medium-sized limbs form a somewhat dense crown of rounded or umbrella-shaped outline. The young tree is noticeably



FIG. 3.—The heavy foliage of slash pine (on the right) in contrast with the thinner foliage of loblolly pine on the left, in South Carolina, where the ranges of these two pines meet and overlap.

straight, with a narrow pyramidal crown of heavy, dark-green foliage above a clean trunk. Slash pine has been pronounced by an eminent tree authority as the handsomest of the North American pines.

³ Unless otherwise stated, all diameters referred to throughout this bulletin are based on measurements at breastheight.

Trees that have reached growth maturity are usually about 100 years old, although many trees live for 150 years, and some more than 200 years.

RANGE AND DISTRIBUTION.

The range of slash pine extends from about Charleston, S. C., westward through southern Georgia, Alabama, Mississippi, and south-

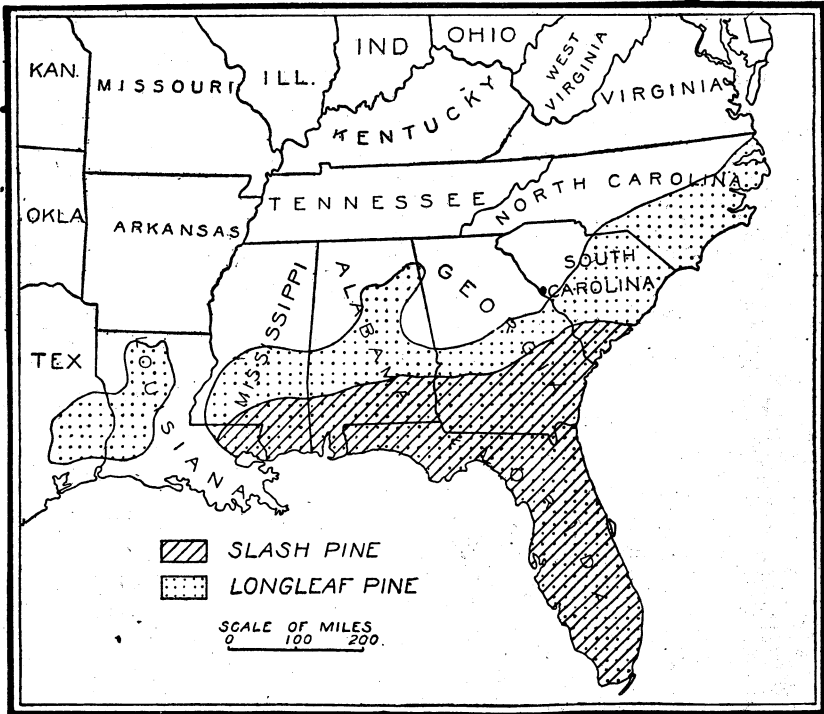


FIG. 4.—The botanical range of slash pine extends from South Carolina west to the Mississippi River (shown by diagonal shading) and overlaps a considerable area of the wider range of longleaf pine (shown by dots).

eastern Louisiana to the Mississippi River, and southward nearly to the southern extremity of Florida. (Fig. 4.) Slash pine is commercially important over its whole range, and over the southern part of the Florida Peninsula it is the chief pine of commercial importance.

In the original forest, confined mostly to the poorly drained flatlands and borders of swamps and bodies of fresh water, slash pine became released with the extensive cutting of the forest, in much the same way as loblolly pine farther north, and it is now spreading widely over lands formerly dominated by longleaf pine. It is found growing on a wide variety of situations, excepting dry, deep, sandy

ridges. On the wire-grass and palmetto flats it is often the only second-growth species of pine. It is aggressively taking lands where some fire protection is afforded, such as wet flatland, abandoned fields, and unused corners about farms and towns and along fence rows, railroad cuts, and embankments (fig. 5). Slash pine thrives in sandy loam soils in poorly drained situations, and is found generally on the wet, mucky soils of bays, ponds, and swamps. It will tolerate a



FIG. 5.—Vigorous slash pine 15 years old, on high rolling hill land in Telfair County, Ga., 125 miles from the coast.

highly acid condition in the surface soil, and a calcareous substratum does not appear to be unfavorable to its growth. On soils with hardpan at shallow depths the tree appears to be somewhat dwarfed in size. It is absent from the very dry, deep sands of the "pine-barren" hills, such as are found in parts of western Florida and southern Mississippi; but even in those sections it is locally abundant on wet flats and close to lakes and streams, and in the numerous ponds scattered all over the Coastal Plain.

SLASH PINE AND LIVE STOCK.

A considerable number of owners in the South are deriving good profits from low-priced lands by using them for the production of live stock and timber.

If fire is excluded, the range yields more of the tender annual grasses and legumes⁴ which are more nutritious than the hardy perennials like wire and broom-sedge grasses, and the influence of the protective soil cover stimulates

tree growth to a marked degree. If the timber in the forest pasture becomes too dense, the owner has an easy remedy for the situation by first working the larger trees for turpentine and then cutting them for lumber, ties, posts, pulpwood, or firewood. Open stands of slash pine, with 75 to 150 trees an acre measuring up to 10 inches on the stump, induce a rapid growth of the individual tree and admit a good growth of grass. In such

⁴ Department of Agriculture Bulletin 827, "The Cut-Over Pine Lands of the South for Beef Cattle Production." 1921.

stands more turpentine per tree is yielded than in overcrowded ones, and the grazing of live stock can be carried on successfully.

Second-growth slash-pine stands, 20 to 40 years old, frequently contain from 80 to 100 trees to an acre. At 20 cents a cup, less than the price received in 1919 for turpentine rights on the Florida National Forest, such stands would be worth for turpentine \$20 to \$25, and with pine stumpage at \$5 a thousand the timber would be worth \$25 to \$30, or a total value of \$40 to \$50 an acre. This represents a gross return in 30 years of \$1.50 to about \$2 an acre yearly. All observations and experience in such older sections of the country, as New England, indicate that good financial returns may be derived in relatively short periods from second-growth southern forests if handled under a proper system of protection, turpentinizing, and cutting.

A SUCCESSFUL TURPENTINE FARMER.

In Clinch County, Ga., a farmer owns about 600 acres of cut-over timberland. Of this, 150 to 200 acres are suitable for improving for cultivation and the remainder is of such character as to be more profitable for live-stock grazing and timber growing. The owner believes that by supplementing the grazing with feed raised for winter use he can maintain on his lands a fair-sized herd of cattle, but he is looking forward with particular interest to the additional profit that will be derived from growing and utilizing his timber to the best advantage.

For a number of years this forester-farmer has been carefully cupping his own timber and selling the gum instead of selling the timber or leasing the turpentine rights. Meanwhile, as an essential part of farm management, he has been keeping fires out, so far as possible, and urging his neighbors and the public as a matter of community welfare, to lend their aid toward fire prevention. As a result of this progressive spirit, and in addition to the income derived from turpentine and the sale of 1,500,000 feet of bled timber, in 1918, this farm operator now has on his place a large amount of thrifty young slash and longleaf pine, which, if handled in the same manner, means a continuous income with a substantial yearly increase for a number of years and an enhancing value of the property. The plan is working out so successfully that the owner is acquiring more land as an addition to his turpentine farm.

In August of the first season (1919) this farmer reported that chipping once a week each thousand cups had yielded a dip of crude gum of about 7 barrels of 280-pounds capacity every 4 weeks. With an average of 6 dippings for the first season, the yield was 42 barrels per 1000 cups. The trees are being worked for 3 to 5 years, or an average of 4 years. The flow of gum each season amounts to about

a barrel less at each dipping. At this rate, 1,000 cups yield 42, 36, 31, and 26 barrels of gum, respectively, for the four years, or a total of 135 barrels of gum. This does not include the "scrape," for which no figures are available. At \$5 a barrel for crude gum, the current local price in August, 1919, the dip from 1,000 cups was worth \$210, \$180, \$155, and \$130, respectively, for the successive seasons for working, or an aggregate value of \$675.

After the trees have been turpentine for a period of 3 to 5 years they are sold for ties or lumber. In 1919 the timber in the standing trees brought from 15 to 25 cents each for ties, the equivalent of \$3.50 to \$4 a thousand feet for saw timber.

As a measure of protection, the owner, in the late fall, rakes a space 18 to 24 inches in width around each cupped tree, and, as soon after rain as the grass becomes sufficiently dry for a slow fire, burns over the ground. In order to lessen damage, the fire is handled against the wind, and as a further protective measure, burning is frequently done at night. It has been found by careful observation and experience that the period from January 1 to February 15 is the most favorable time of the year for such burning. Under these conditions of light burning the flames, as a rule, do not rise high enough to injure the boughs of the small pines, and as a result the owner, while deriving a continuous profit from it, is making a notable success of perpetuating the forest.

RATE OF GROWTH.

Slash pine is one of the most rapid growing and earliest maturing forest trees. Growth in height is particularly rapid during the younger stages, up to about 20 years of age. In the first year, seedlings commonly reach 8 to 12 inches in height. At 5 years old slash pine in stands ranges mostly from 6 to 10 feet in height. During the next 5 to 10 years an upward growth of 2 to 3 feet yearly is not uncommon. Probably no other eastern species of conifer equals slash pine in its very early height growth. When about 25 to 35 years of age the rate of upward growth of slash pine slackens, apparently being about the same as that of longleaf on similar grades of situation. Growth in diameter is also rapid. In fully stocked stands the increase in diameter is relatively slow as compared with that of trees standing a considerable distance apart. (Fig. 6.) Table 1 shows for different ages the average height and diameter of slash pine trees and the number of trees per acre growing in well-stocked stands. The range in size at any given age varies chiefly with the favorableness of the situation in which the tree or the stand of trees is growing, and with the tree density or number of trees growing on a specified area.



FIG. 6.—The adaptability of slash pine to heavy wet soils enables it to grow rapidly even in dense stands, thus producing a large amount of timber in a relatively short period.

TABLE 1.—Average growth in height and diameter of trees and number of trees per acre, growing in well-stocked, even-aged slash-pine stands on various qualities of land.¹

Age of stand.	Height.			Diameter ^a (breastheight).			Approximate number of trees per acre.
	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.	
Years.	Feet.	Feet.	Feet.	Inches.	Inches.	Inches.	
10	34	25	10	4.0	2.5	1.0	1,000 to 2,500.
15	45	35	25	6.5	4.7	3.0	700 to 1,800.
20	55	45	35	8.5	6.3	4.0	500 to 1,200.
25	64	54	44	9.5	7.5	5.5	300 to 900.
30	68	60	50	10.5	8.3	6.0	200 to 650.
35	74	64	55	11.0	9.0	7.0	150 to 500.
40	78	68	59	12.0	10.0	8.0	125 to 400.
45	81	72	63	12.5	10.5	8.5	100 to 325.
50	84	74	65	13.0	11.0	9.0	90 to 275.

^a Diameters measured at breastheight, or 4½ feet above the ground.

The individual trees in well-stocked stands at 15 years of age, for example, usually range from 25 to 45 feet in height and 3 to 6 inches in diameter. (Table 1.) At 30 years, an age when large amounts of slash pine is merchantable, the trees range from 6 to over 10 inches in diameter and 50 to 68 feet in height. If, however, the trees have grown more openly, with the fullest space for development, it is not uncommon at 25 years for the trees to average from 10 to 14 inches in diameter and from 50 to 70 feet in height. An open stand in northeastern Florida is shown in figure 7, where the average tree of the 17-year-old stand was nearly 11 (10.7) inches in diameter and 61 feet tall. Fire protection had been afforded throughout the life of the stand, which undoubtedly accounts for the large size and thriftiness of the trees and the maximum timber yield of the stand. Such open-grown or orchard-like stands favor the early production of merchantable sawlogs and turpentine, but sacrifice a much larger production per acre at a later date. However, moderately open-grown stands should often be favored over too dense stands. An average of the number of trees, shown in Table 1, as well as the medium diameters in the fifth column, may be taken as an approximate guide to fairly good forest conditions.

On very wet or highly acid soils, on which slash-pine seed freely germinates, the tree often makes rather slow growth and reaches only a medium size at maturity. In such situations the trees have characteristic flattened tops.

EFFECT OF TURPENTINING UPON GROWTH.

Owners who are handling their timber carefully, with the purpose of getting the most out of it, both of gum and lumber, are watching

¹ Preliminary table, based upon insufficient measurement and not to be considered as a final table.

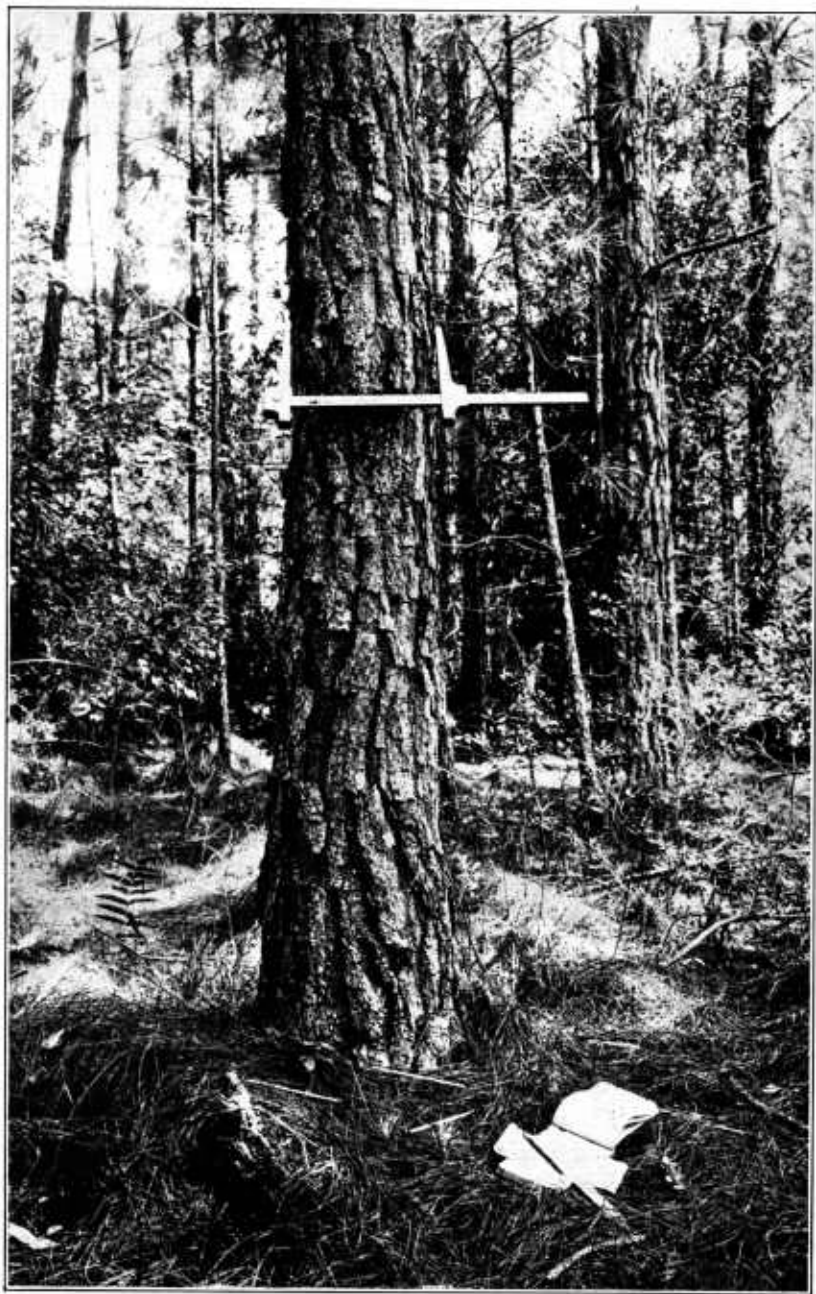


FIG. 7.—Maximum growth of slash pine resulting from continuous fire protection. The trees in this 17-year old unburned stand measured mostly from 8 to 13 inches in diameter and 50 to 65 feet tall. The average tree was 10.7 inches in diameter (breasthigh) by 61 feet tall. In the 17 years this open-grown stand had produced 12,600 board feet of lumber. The thick mat of pine leaves or straw, plainly seen in the picture, affords favorable soil protection against extremes of heat and moisture.

with interest the effect of turpentine upon the subsequent growth of the tree, particularly young timber. This is a question wholly outside of the injury and losses of timber through bad methods of working, fires, wind, and insects following turpentine operations. Although the effect of turpentine upon growth has not been definitely determined, and additional studies will be necessary to establish this point, a decrease in growth as a result is clearly indicated.

The majority of trees show a check in the rate of their growth, even when worked with only one face. On a slash pine tree, measuring 11 inches in diameter by 53 feet high, full crowned and vigorous, a face which had been made during a working about seven years previously



FIG. 8.—The wood of this rapidly-growing tree, 17 years old, consisted of 63 per cent of dense summerwood—a very high percentage for any tree at any age. The high density of its wood from early life is a characteristic of slash pine.

was rapidly healing over. In the time elapsed, however, the tree had grown only 2 feet 9 inches in height and less than 1 inch in diameter, or about one-half the normal rate for near-by trees which had not been worked. This result does not always follow, however, and growth on worked trees frequently takes place in the same manner as on neighboring trees not worked, the face healing over rapidly. The cutting of two faces on second-growth timber often causes heavy check upon growth, besides mechanically weakening the tree to a serious extent. Trees below 12 to 14 inches in diameter grow so slowly following double facing that it would probably be better to work them completely, so as to kill them, and let the space be taken by new growth.

It appears certain that exposure to fires and the injurious agencies of rot and insect infestation subsequent to turpentine have much to do with any decline in growth that may occur along with that from the wounding and attendant loss of resin. In case this assumption be correct, it follows that slash pine, if rightly handled, may be turpentine to advantage in advance of the final working and harvesting of lumber.

TIMBER PRODUCTION.

Slash pine produces the heaviest, hardest, strongest wood of all the commercial conifers in the United States.⁵ The weight of the air-

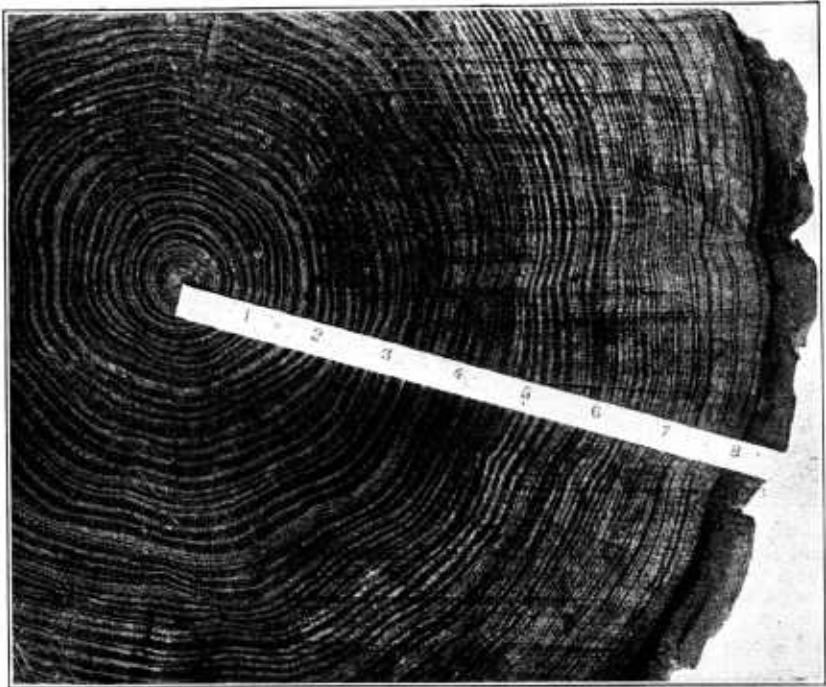


FIG. 9.—Wood from a forest-grown slash pine about 90 years old, selected as average of many specimens and representative of the timber cut from mature trees.

dry wood averages 45 pounds per cubic foot, and is exceeded among the more important commercial timbers only by the hickories and heavier white oaks. It is heavier than hard maple and beech, and about equal to white ash, yellow birch, and bur oak. In the butt cut the wood averages about 55 per cent of dense bands or summerwood,

⁵ According to results of tests made at the Forest Products Laboratory, U. S. Forest Service, in cooperation with University of Wisconsin, Madison, Wis., the wood of slash pine averages a little heavier, harder, and stronger than that of longleaf.

while farther up the tree the proportion of summerwood decreases, at the top of the second cut to about 40 per cent. (Figs. 8, 9, and 10.)

Lumber of slash and longleaf pines is manufactured and marketed without distinction, and the high density of slash pine makes the wood grade high under the standard density rule.⁶

The uses of slash-pine lumber are well known. It is widely used for structural purposes and is in demand for bridges, trestles, docks, warehouses, and factories, in which it is employed for dimension timbers, posts, piles, and joists. On account of its strength and stiffness, large amounts are used for railroad cars, and its hardness and wearing qualities make it one of the leading woods for flooring



FIG. 10.—Logging mature slash pine in the flat woods of northern Florida. Because of the similarity of the woods, slash pine is cut and marketed without distinction along with longleaf pine. Note the large amount of damage to standing timber by repeated forest fires.

and street-paving blocks. The wood is also extensively used for implements and machinery, frames, and sashes, as veneers for boxes and other packages, and as boards for slack cooperage.

Young or "sap trees" of slash pine are extensively cut for railroad ties, on account of the density and hardness of the wood and its ability to take preservative treatment, and because slash pine occurs in dense stands of tall trees. Young trees about the best size for turpentine working are eagerly sought for cutting into railroad ties.

The wood of slash pine is well adapted for paper pulp, and the pulp mills located in Georgia, Alabama, Mississippi, and Louisiana take it readily along with that of other pines (fig. 11). The

⁶ For information regarding the grading of southern pine, application should be made to the secretary, Southern Pine Association, New Orleans, La.

resinous matter in the wood does not interfere with its manufacture into "kraft" paper, a good grade of brown or wrapping paper of various thicknesses and shades of color. Slash pine, though not sold as such, finds a ready sale for fuel purposes on account of the highly resinous character of its wood. The clearing of old fields in the lower Gulf region, a large part of which is covered with slash pine, results in large amounts of cordwood coming on the market.

YIELD OF STANDS.

Owners of slash pine and others interested in growing it will want to know how much cordwood (fuel wood or pulpwood), crossties, and saw timber each acre is capable of producing. A knowledge



FIG. 11.—Tops and limbs of slash pine left in logging in Louisiana worked up in cordwood for paper pulpwood. This mill requires about 300 cords of pine wood daily throughout the year.

of the average yield at various ages, as well as the number of trees per acre and the average size of the trees, will help in deciding the most profitable time to cut the timber. The sizes and yields shown in Tables 2 and 3 refer to well-stocked stands, such as are commonly known as "dense" growths of trees. Actual stands may vary in yield all the way from 10 per cent to the full amount shown in the tables.

The amounts of various products referred to in the tables are based upon measurements of sample areas selected as being representative of the best, or ideal, conditions in respect to the density or number of trees per acre. Such well-stocked stands have enough trees so that

all the available air space and available soil moisture are fully utilized. Fully stocked stands do not occur continuously over large areas, but are confined generally to tracts at most containing up to a few acres in area, such as old fields, or the paths of tropical hurricanes; the figures of amounts per acre are consequently much higher than those that would result from the cutting of ordinary stands. In using such ideal tables there is always great danger of overestimating the amount of timber that is produced and may be cut from average stands as they are commonly found.

Well-stocked stands of slash pine increase their production of wood per acre rapidly up to a certain age and more slowly afterwards. At some period, considerably beyond the ages of the young second growth here under discussion, the trees begin to die out from old age, and the actual amount of wood per acre decreases.

CROSSTIES, FUEL WOOD, AND PULPWOOD.

The rate of production of cordwood for slash pine is yearly about 2 to 3 cords of wood with the bark, or $1\frac{1}{2}$ to 2 cords of peeled wood (pulpwood) between the ages of 10 and 15 years; at the ages of 20 to 25 years about $1\frac{1}{2}$ cords of fuel wood, or 1 cord of pulpwood; and at 35 to 40 years a little less than 1 cord yearly (Table 2). The standard cord is a stack 4 feet wide by 4 feet high by 8 feet long, containing 128 cubic feet. Such a stack of piled sticks consists of about 90 cubic feet of solid wood, varying with the straightness of the sticks and method of piling.

On most lands only scattering trees grow, or a fraction of a full stand. The trees, although individually growing much faster than in crowded stands, do not yield in the aggregate so much wood. An acre containing 100 trees, ranging from 8 to 14 inches in diameter and 50 to 70 feet high, such as might be found frequently on average cut-over lands, would cut about 25 cords of fuel wood or 20 cords of peeled pulpwood, or about 30 to 40 per cent of the yield of a fully stocked stand.

The approximate number of crossties of standard size, 6 by 8 inches by 8 feet, that can be cut in well-stocked slash-pine stands at various ages, is shown in Table 2. With a good market prevailing generally over the South for railroad ties, small-sized timber can often be worked up advantageously into crossties. This is particularly true of the small stunted trees that should be thinned out of timber which it is desired to grow for saw-timber sizes.

TABLE 2.—Yield of well-stocked slash-pine stands per acre in the form of cross-ties, pulpwood, and fuel wood.¹

Age.	Cross-ties, No. 3 (6 by 8 feet).	Cordwood.		Age.	Cross-ties, No. 3 (6 by 8 inches by 8 feet).	Cordwood.	
		Peeled wood (pulp wood, etc.).	Wood with bark (fuel wood, etc.).			Peeled wood (pulp wood, etc.).	Wood with bark (fuel wood, etc.).
Years.	Number.	Cords.	Cords.	Years.	Number.	Cords.	Cords.
10	1 to 8	2 to 12	30	80 to 310	25 to 50	32 to 62
15	9 to 20	12 to 27	35	130 to 340	28 to 54	35 to 66
20	Up to 190	15 to 35	20 to 46	40	170 to 365	31 to 58	40 to 70
25	Up to 270	20 to 45	27 to 56				

¹ This is a preliminary table, based on insufficient measurements to make the figures final. The range of figures shows the different yields on different qualities of land.

YIELD OF SAW TIMBER.

The market is taking lumber cut from smaller and smaller sized timber. This is particularly true in the South. Increasing amounts of slash pine for both local use and shipment are being sawed each year from small turpentine trees from 25 to 40 years of age.

Table 3 summarizes the approximate amounts of saw timber per acre, in terms of board feet, that can be cut from slash-pine stands of different ages, growing in well-stocked stands of approximately even-aged trees. For example, a slash-pine stand about 30 years old, of good density, taking all trees measuring 10 inches and over in diameter at breastheight, when closely sawed may be expected to yield from 2,300 on poorer land up to 13,600 board feet on better situations. If all trees measuring 8 inches and over in diameter are sawed up, the yield should be somewhere between 5,500 and 16,000 board feet. This represents an average yearly production, considering the 10-inch diameter limit, of about 260 board feet per acre, and 360 board feet for trees 8 inches and over. For the average sizes of the trees and number per acre for the corresponding ages, reference should be made to Table 1.

TABLE 3.—Amount of saw timber in board feet grown in slash-pine stands that are even aged and well stocked with trees.¹

Age of stand.	Mill scale, or actual cut. ²						Doyle rule. ³		
	Trees 10 inches and over in diameter.			Trees 8 inches and over in diameter.			Trees 7 inches and over in diameter.		
	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.	Better land.	Medium land.	Poorer land.
Years.									
20	5,900			9,800	5,350	900	3,900		
25	10,600	5,600		13,600	8,500	3,400	5,860	3,505	1,150
30	13,600	8,000	2,300	16,200	10,850	5,500	7,220	4,710	2,200
35	15,800	10,200	4,700	18,100	12,700	7,300	8,300	5,700	3,100
40	17,600	12,200	6,700	19,600	14,200	8,800	9,200	6,600	4,000
45	19,000	13,700	8,400	20,800	15,400	10,000	10,050	7,385	4,720
50	20,200	15,000	9,900	21,800	16,450	11,100	10,750	8,075	5,400

¹ See attached sheet for footnote.

² The yield in lumber when closely and carefully sawed down to a top diameter inside bark of 3.5 inches.

³ By the Doyle rule small logs scale from one-third to one-half less than the amount that can be cut in careful and close sawing.

The future yields of present stands, if left to grow for 5, 10, 15, or more years, can be predicted by referring to the yields for the corresponding ages in Table 3.

This table is for stands having approximately the proper number of trees fairly evenly spaced on the ground. The amount of lumber shown by mill scale is that which can be sawed out by using the trees down to small diameters and utilizing the material in the logs by careful sawing (with an ordinary circular saw) rather than by the old-time rough-and-ready, wasteful methods. The difference between the mill scale and the scale by the Doyle rule is striking. For example, an acre of 25-year-old slash pine well stocked on the ground, if carefully sawed, taking all trees measuring 10 inches and over in diameter (breast high), would yield on medium land up to 10,000 board feet. The very low scale of the Doyle rule, which unfortunately prevails in common use, is shown by the fact that measuring by that rule the logs from all trees in the same stand, 7 inches and over in diameter and on the same grade of location, would scale only up to 4,710 feet.

The following essential facts concerning a few of the stands actually measured will serve as an illustration of what yields may be expected from well-stocked slash-pine stands, such as are locally considered to be "dense" stands.

(1) A 21-year-old stand, consisting of 384 trees per acre, averaging 8 inches in diameter at breastheight and 56 feet in height, contained 45 cords of wood with the bark on, or 34 cords of peeled wood. If all trees measuring 10 inches and over in diameter were cut, the stand would saw out about 6,400 board feet; or if all trees 8 inches and over were taken, it would saw about 10,300 board feet. By the Doyle log rule, however, all trees measuring 7 inches and up in diameter would scale only 3,700 board feet.

(2) A 25-year-old stand, with 274 trees per acre, averaging 63 feet in height and 9 inches in diameter, contained 47 cords of wood with the bark, or 37 cords of peeled wood. The trees 10 inches and over in diameter would saw out, down to small top diameters, about 10,700 board feet per acre; or about 13,500 feet would be obtained if trees 8 inches and up in diameter were taken. If the logs in the trees measuring 7 inches and over in diameter were scaled by the Doyle rule, there would be only 5,800 board feet per acre.

(3) A 26-year-old stand, with 754 trees per acre, would cut 64 cords of wood with the bark, or 47 cords of peeled wood. There would be a total of only 1,300 board feet if trees measuring 10 inches and up were taken, or 8,000 feet from all trees 8 inches and over in diameter. The Doyle rule showed only 1,360 board feet.

(4) A 30-year-old stand, with 114 trees per acre, averaging 11 inches in diameter and 69 feet high, contained 31 cords with the bark, or 25 cords of peeled wood. There would be 9,672 board feet per acre of saw timber in the trees 10 inches and over in diameter, or 10,700 board feet in the trees 8 inches and over in diameter. If scaled by the Doyle rule, the stand had only 5,700 board feet.

(5) A 51-year-old stand, which consisted of 220 trees per acre, averaging 70 feet in height and 9.4 inches in diameter, contained 57 cords of wood with the bark, or 44 cords of peeled wood. The stand would cut out 10,100 board feet from all trees 10 inches and over in diameter, or 14,600 feet from trees measuring 8 inches and over. The Doyle rule gave only 5,900 feet of saw timber.

TURPENTINE AND ROSIN PRODUCTION.

Slash pine produces large quantities of rosin, or gum, of high quality. In this respect it excels all other native pines.

The gum of slash pine, when freshly exuded, is limpid, and about the color of light-yellow honey. As compared with longleaf or "hill" pine, its nearest competitor, it yields a higher percentage of turpentine and a relatively smaller amount of rosin of a higher grade. Beginning to run a little later in the spring than longleaf, probably because of the colder situation in low ground, slash pine keeps up a heavy flow until late in the season, considerably past the time when longleaf becomes dry-faced; furthermore, it does not produce "scrape," as does longleaf. It is not uncommon to hear it said that slash pine is more apt to die from turpentinizing than its associate, longleaf pine. Observations make it almost certain that the basis for this statement is the almost universal custom of more heavily cupping slash pine because of its very free production of crude gum, with its high content of spirits of turpentine, and the desire to obtain the maximum amount.

It is difficult for private owners and operators to break away from the custom of cupping very small trees and overcupping large ones. In their desire for immediate returns they sacrifice heavily in income, or "kill the goose that lays the golden egg." A case is known where slash-pine trees were cupped at 8 years old and the same trees back-cupped 7 years later. Frequently all trees down to 7 inches in diameter are cupped, two cups hung on trees down to 9 or 10 inches, and three cups hung on trees 13 inches and over by the laborers who are paid on the basis of each 1,000 cups hung, or of each "crop" of 10,000 cups. Very close working is wasteful practice, except for the purpose of clearing up land or thinning heavy stands. (Fig. 12.) With the faces ranging in width from 7 to 11 inches, the bars (portions of bark and wood left between the faces) are reduced to widths from 1 to 3 inches, which are entirely too narrow to permit of the trees functioning properly.

The flow of gum appears to be generally in proportion to the size of the trees and the size of the face, up to the point where the tree is faced too severely. Practical men in the turpentine industry are heard repeatedly expressing the opinion that a large percentage of the smaller-sized trees now bled are too small to pay for the cost of

operation. The almost complete loss by wind and fire of small trees during or after severe turpentine operations is another potent economic reason for adopting conservative methods. (Fig. 13.)

IMPROVED METHODS OF TURPENTINING.

The ultimate aim in the conservative handling of slash-pine stands is to make them continuously productive and capable of supporting a permanent and self-sustaining industry. The continuous operation of turpentine forests has been practiced for many years in France and is regarded by well-informed persons as possible and practicable in this country.



FIG. 12.—Slash pine in central Georgia ready for thinning by turpentine. The trees are 20 years old, from 5 to 10 inches in diameter and 45 to 55 feet tall. There are 474 trees of the larger sizes an acre and 922 trees an acre of all sizes.

The cupping method, instead of the wasteful boxing of trees, has become generally used by the more progressive operators, but unfortunately it is not yet prevailingly adopted. Light chipping is a step toward improved methods for securing increased yield and lessening destruction of timber. Another step in the right direction for conservative operating consists in restricting the cupping of young trees of sizes below certain minimum diameter limits, and greatly lengthening the period of operation on the individual tree and forest by proper regard for the laws of tree life, including the production of resin by the tree. A successful farmer in south Georgia, in a recent lease of turpentine rights on his timber, made the following restrictions which are probably typical of what the more conservative owners regard as the best practice with their timber:

No tree shall be bled measuring below 10 inches at 2 feet from the ground; 1 cup to be allowed on trees from 10 to 14 inches, inclusive; and 2 cups on trees 15 inches and over in diameter.

A summary of practices that are more generally recognized to be advisable as a means of getting the most revenue out of their timber, consistent with conditions of labor and market, includes the following:

(1) The cup-and-gutter system should be exclusively used. The advantages of the cup-and-gutter system over that of boxing are that (a) the yield of turpentine is considerably greater and the quality of the rosin better; (b) the loss and damage from fire is greatly lessened through the elimination of the deep cut (box) into the tree;



FIG. 13.—Early loss of small slash pine timber from deep chipping. If cupped only on one side these small trees are nearly half way cut through, making them easy prey for wind of only moderate force.

and (c) less injury being done to the tree, it is enabled to maintain its vigor and is less liable to be wind-thrown. One count, following a windstorm on two adjacent tracts, showed that 13 boxed trees were blown down to 4 cupped trees; also that 37 of the boxed trees died to only 17 of the cupped trees.

(2) No trees under 10 inches in diameter (breast high) should be tapped.

(3) Two faces should be allowed on trees measuring 14 inches and over in diameter at breast-height.

(4) Not more than two faces should be allowed on any tree.

(5) The faces on trees 12 to 15 inches in diameter should not exceed 12 inches in width; and those on trees above 16 inches in diameter should not exceed 14 inches in width.

(6) The height of the face should not be raised in any one year more than 16 inches, or an average of 0.5 inch in height for each 32 streaks in season.

(7) No streak should exceed a depth of 0.5 inch, the depth being measured from the dividing line between the wood and bark, the practice being known as "light chipping."

(8) The rough or outer bark of such tree to be chipped should be scraped off clean at the opening of the season before chipping begins.

(9) A space of at least 2.5 feet on all sides of each tapped tree should be raked free of litter or débris during the winter following the working.

Investigations must be carried on further to secure the information necessary for recommending any final plan of forest operation which will secure a continuous yield of turpentine. The plan briefly outlined below for second-growth slash pine will doubtless suggest ideas to owners who desire to handle their stands so that they may, in the long run, secure a continuous profit. No attempt has been made to give details, and as much latitude as is necessary is allowed for the working out of the plan.

A TURPENTINE PLAN.⁷

Turpentine operations begun when a considerable number of trees in the forest—say one-fifth to one-half—have reached 10 inches and over in diameter. Under average conditions of soil the forest will reach this stage of development at 20 to 30 years of age, varying with the tree density, or the number of trees per acre, and with the degree of fire protection. All trees 10 inches and over are then cupped with one cup per tree and carefully worked or lightly chipped for a period of 3 years to a height of not over 6 feet from the ground. The forest is then allowed to rest.

The success of the plan requires keeping up midwinter raking around the trees during periods of rest as well as of operation and the protection of the timber against heavy burnings. In about 7 years, or 10 years after the beginning of the first working, the larger trees will have reached such size that they will stand a second cupping, and many others will have reached or passed the minimum 10-inch diameter size limit. (Fig. 14.) When it appears desirable to thin out trees, for the better development of the forest as a whole, they are double-cupped and worked as heavily as possible for gum, and the remaining trees then worked with not more than one cup to the tree. At the end of this second cupping the trees previously selected for thinning are removed, together with any others that are badly injured or affected with disease or that look unpromising from

⁷ Suggested by Mr. Austin Cary, of the Forest Service, U. S. Department of Agriculture.

any other cause. If the timber is thrifty, the best course after a period of rest and growth, varying in duration from 3 to 7 years, is to work the forest a third time.

At the close of this period the trees will have been completely worked over and should have reached a size serviceable for lumber. At the age of 35 to 55 years, on average locations, the trees may be expected to scale from 80 to 150 board feet of lumber, and it is practicable for them to stand 100 or more on an acre. The total yield will depend upon the number and size of trees removed after each turpentine operation. The system, when once started, will work continuously through the incoming of young growth, and may be expected, on such quality of land as is under consideration, to produce a yield in naval stores equivalent to the product from 3 to 12 faces per acre working continuously, and a yearly product per acre of 100 to 400 board feet of lumber.

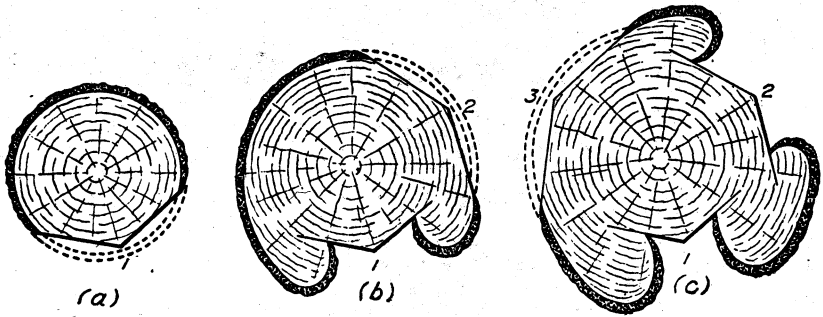


FIG. 14.—Three successive workings of a slash pine tree: (a) First working when 10 inches in diameter (breasthigh); (b) second working 6 years later, after 3-year rest period; and (c) third working 12 years later after high-facing the second working and allowing a 6-year rest. The tree has had sufficient live bark to keep it actively growing, although the rate of increase in size was slow while being turpented as compared with other years.

TURPENTINING IN FRANCE.

Owners who desire to operate their young timber in the most profitable manner, after it has reached the stage profitable for turpentine, will be interested in a brief account of the methods that have been worked out during the past 70 to 100 years by the French Government in handling its forests of maritime pine (*Pinus maritima*) for turpentine and timber. Although an inferior tree for lumber, maritime pine is similar to slash pine in that it grows rapidly and yields turpentine gum freely from faces which heal over in a comparatively short time. By careful working, turpentine operations are carried on continuously in the same stand for a period of 45 to 50 years.



FIG. 15.—French turpentine on maritime pine under private ownership. The faces are concave and from 3 to 4 inches wide, depending upon the size of the tree and intensity of operation. The yield of gum per inch of face is more than that in this country. This form of face does not seriously weaken the tree, and in a few years is entirely grown over.

When a stand reaches the age of about 25 years a period of improvement thinning is begun, which lasts about 15 years. During this period, at 5-year intervals, those trees which it is desired to remove so as to stimulate crown expansion and diameter increase in the remaining trees are marked for turpentine working. When the trees are selected for early removal they are heavily cupped, under a rapid "destructive" system of turpentine for three or four years and then cut for lumber.

At the end of the above period of thinning, or at the age of about 40 years, the trees of the final stand, which number from 150 to 200 per acre, are found to be uniformly spaced, well separated, and growing vigorously. At this time is begun a period of conservative tur-

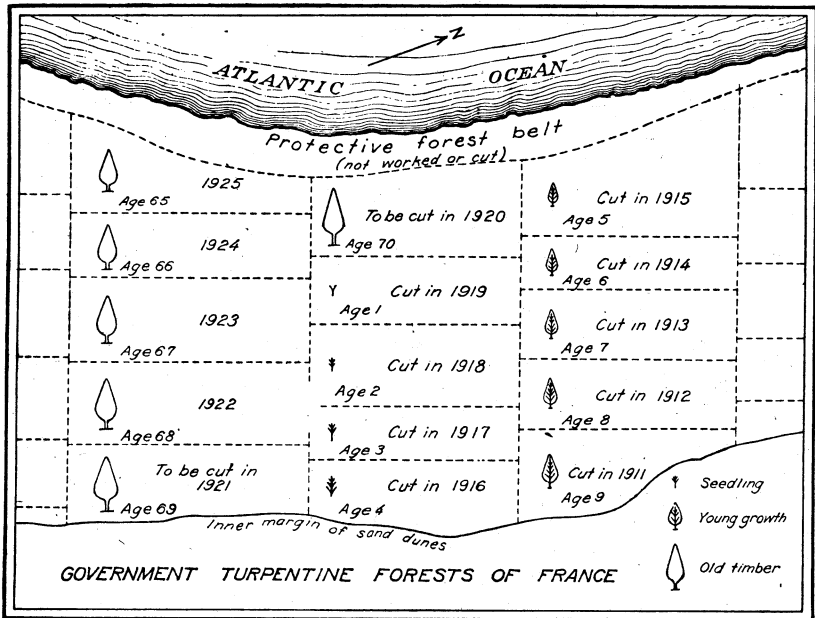


FIG. 16.—Government owned maritime pine forests of France.

pentining, lasting about 30 years, or to the end of the "rotation" of 70 years, when the stand or "block" is considered to have reached its maturity and is cut. All trees in the stand are cupped with one face to each tree and worked for five successive seasons, then allowed to rest for a period of not less than 3 nor more than 5 years. A back face is then begun and worked for 5 years, followed by a similar resting period. Then a new face is started midway between the old faces, and so on. The faces, which are from 3 to 4 inches in width, heal over rapidly. This makes it possible to start new faces or work-

ings on the same tree regularly every 8 to 10 years, depending upon the length of the resting period. (Fig. 15.) On designated trees two cups may be allowed.

Near the end of the rotation or maturity period, just prior to the final cutting, the trees in the block for 4 years are turpentine heavily by the "destructive" system in order to obtain the maximum yield of gum. At this time the stand contains from 75 to 150 trees an acre. The reduction represents losses by storms, insects, diseases, and the occasional removal of trees for which there was a special demand or which yielded more profit for wood than for producing turpentine. After the final cupping the whole stand or block is cut clean for lumber, ties, and fuel wood. No part of the tree is left on the ground except the small branches and twigs containing the foliage and cones or "burrs," which set nearly every year and persist on the trees for several years. From the plentiful seed in the cones the land is soon reforested with abundant young growth. Fires are rigidly guarded against at all times, and carefully cleared fire lines are maintained across the forest at more or less regular intervals.⁸

Each year one block of the forest is cut, thinnings are begun in another, and the block cut the year before commences to reforest naturally. As shown in figure 16, the cutting progresses westward or toward the direction of the prevailing winds in order to afford the young stands the greatest degree of protection against severe winds. Although under Government ownership the turpentine and timber-cutting rights are sold to private operators for periods of 5 years, which accounts for the arrangement of the cutting compartments, each consisting of a series of five stands or blocks.

⁸ For further information regarding the French method of turpentine, see Department of Agriculture Bulletin 229, "The Naval Stores Industry."

WHAT FRANCE HAS DONE.

In France there are to-day 1,500,000 acres of private pine forest, by far the greater part of which was established on treeless sand wastes of the coastal plain, by sowing seed or by planting little trees. Much of that land is now worth from \$100 to \$200 an acre.

During the war, American foresters (Twentieth Engineers), in France, cut saw logs from trees in State forests located on sand dunes which, 60 years ago, were not only wholly unproductive, but a menace to the country, because they were traveling inland at the rate of 80 to 100 feet a year.

Forest planting in France has resulted in creating a naval-stores industry second only to that of the United States, in draining malarial marshes, in vastly increasing population, and in bringing lands up to a state of good agricultural production by means of utilizing the forest undergrowth and pine "straw" or leaves.

By careful methods of working, the French forests—built up from the reforestation of treeless wastes—are made to yield turpentine for periods of 30 to 50 years, after which the trees are cut for timber. The same transformation can be brought about on the cut-over pine land of the Southeastern States.

REFORESTATION.

The natural restocking of slash-pine lands with young growth may be expected to take place satisfactorily whenever sufficient seed trees are left in logging. The rapidity with which young slash pine takes possession of old fields, wet lands, vacant lands near towns and on farms, and other places protected from fire, is locally well known. The reforestation of land by means of sowing seed or planting small seedlings doubtless seems quite unnecessary and impracticable in the South, where there is already so much young growth. Such reforestation is not proceeding everywhere, however, and on account of modern methods of steam logging and the almost yearly burnings, vast areas in the South which should be growing timber are now practically idle. Many owners of small tracts and some owners of large ones are, however, seeking information regarding methods of getting young pine growth on their land.

NATURAL REPRODUCTION.

Slash pine is a somewhat heavy seed producer. Full or heavy seed crops may be counted on at intervals of two to three years, although some seed is borne almost every year. Well-developed cones ("burrs") have been observed on trees 12 years old; but, in general, trees growing in the open produce seed only after reaching the ages of 15 to 18 years. In close stands seed production, usually limited in quantity, begins at a little later age. The seed is small and provided with a wing by which it is easily carried in moderate winds as far as 100 yards, and in strong winds it often travels two or three times as far (fig. 2). As a result the seed is widely dispersed. There are about 16,000 to 18,000 seed in a pound, with 60 to 90 fertile seed in every hundred. The seed appears to retain its vitality well in storage. Seed stored for two years in covered tin containers, at ordinary office temperatures, when tested showed a germination of 70 per cent, in which one-half the seeds germinated within the first two weeks after sowing; another lot of seed similarly stored in cloth sacks for three years resulted in 28 per cent germinating. In size and general appearance the seed closely resembles that of loblolly pine, with which it is very apt to be confused. No destruction or injury to either seed or sapling by "razor-back" hogs has been reported, in striking contrast to that occurring with longleaf pine.

Slash-pine seed germinates usually in the fall, within a month after it reaches the ground. If there has been a full seed crop accompanied by favorable weather during the fall and winter, as occurs at intervals of some 3 to 7 years, heavy reproduction results widely over the range of the species. A good supply of moisture is favorable to successful seed germination and the early growth of the seedlings. This, together with better fire protection, largely accounts for the abundance of slash pine in moist situations and its infrequency on markedly dry sites. The broad margins of bodies of water, grass bogs in swamps, and flatlands liable to be water-soaked for some time are favorite situations for slash-pine reproduction. Cultivation of abandoned fields disintegrates the underlying hardpan and affords moisture conditions favorable for seed beds. Young slash pine growing on such fields is commonly termed "oldfield" pine. Unfortunately, fires, which commonly occur annually or every two years, destroy vast numbers of the young pine growth of all species over the whole pine belt.

If it is desired to obtain young growth by natural means following logging, as in the continuous handling of slash-pine stands, it is necessary to provide for seed trees. The figure on the back cover of this bulletin shows a mother seed-tree left after logging and the offsprings about 5 years old. Good seed-trees have short, clear trunks

and heavy tops and show vigor of growth by their full green foliage. These trees cut low-grade lumber and may be left without sacrifice of valuable timber. If grass, pine "straw," or other leaves have formed an exceptionally thick cover over the mineral soil or muck, it might be advisable to "light burn" the land during the winter or early spring preceding a full crop of seed, whether or not the timber be cut. Such action is, however, required far less often with slash pine than with longleaf, which produces a seed of large size.

SOWING AND PLANTING.

The absence of seed-bearing trees sometimes makes it necessary to start young forest growth by means of so-called "artificial" reforestation. This is merely getting a stand of trees started either by sowing the seed or by transplanting seedlings previously dug up or grown in nursery beds. Slash pine is well adapted to reproduction by either method and can be easily and successfully handled. It has a small taproot and stands transplanting well if ordinary care is taken. Slash pine, like southern cypress, shows a tendency to migrate northward, and, like many forest trees, is without doubt capable of being extended to a considerable distance beyond the limits of its present natural range.^a

BROADCAST SOWING.

Broadcast sowings of slash-pine seed on grassy lands, followed by dragging with a spring, spike-tooth, or brush harrow, depending upon the character of ground cover, have given excellent results. A fairly heavy grass cover acts as a protection, and under such conditions better results have followed than where similar land has been freshly burned over. Plowed land broadcasted with seed and harrowed has produced practically complete stands, but the method is expensive. A sowing at the rate of 1 to 3 pounds of seed per acre seems to be sufficient to produce satisfactory stands of trees under ordinary conditions. Low, grassy lands require less seed than ridge or thinly grassed lands. Sowing seed on grass without further treatment is simple and relatively cheap and has thus far given satisfactory results. Fall sowing has resulted in a higher seed germination than sowing in the spring. It is recommended that the collection of seed in late summer or early fall be followed soon by sowing operations, preferably not later than the middle of October. For spring sowing February or March would probably be the most favorable time.

In the fall of 1917 and spring of 1918 slash-pine seed was sowed by the Forest Service in cooperation with Clemson College at the Clem-

^a The Forest Service, U. S. Department of Agriculture, furnishes lists of dealers quoting prices on seeds and seedlings of forest trees, including slash pine.

son Coast Experiment Station, near Summerville, S. C. The land is fairly low, flat, and poorly drained, about 20 miles inland from the coast. Locally it is known as "crawfish" land and represents large areas of the Atlantic and Gulf Coastal Plain. Broadcast and seed-spot methods of sowing were used under different conditions of grass cover with varying results up to about 87,000 seedlings per acre. This last result came from early November sowing on heavily grassed-over land, followed by harrowing; a similar sowing in the grass, but without harrowing, gave a stand of over 32,000 seedlings an acre. Similar broadcast sowing on a ridge with sparse grass cover and without harrowing after seeding resulted in 544 seedlings an acre, and, with the ground harrowed after seeding, in over 3,400 seedlings. In all operations seed was sown at the rate of 5 pounds an acre.

An identical series of sowings on grass-covered lands, made in March and early April following, gave a considerably less but still satisfactory number of established trees an acre.

Experiments have shown that an initial stand of about 5,000 first-year seedlings an acre should be a sufficient number for average conditions. On this basis about 1 to 3 pounds of seed sowed on low, moist, grassy lands, without further treatment, such as harrowing, should ordinarily result in a stand of satisfactory tree density.

SEED-SPOT SOWING.

Another method is to sow a dozen or more seeds in a "hill," or seed spot, dug up about a foot square and prepared for the purpose with a hoe or mattock. The seed are then covered, by hand or with an implement, with about one-quarter of an inch of soil, lightly tamped to prevent rapid drying. The seed spots are usually spaced at more or less regular intervals, depending upon the desired spacing of the young stand. A spacing of 8 by 8 feet requires 680 seed spots per acre and is generally considered a good average spacing. No better results have been obtained by this method than by the less expensive one of broadcasting and harrowing.

GROWING AND PLANTING SEEDLINGS.

Seedlings of slash pine for transplanting may be obtained by digging them up in the woods or growing them from seed in small beds in the garden. Experience indicates that slash pine possesses inherent vigor and favorable root form, which make it one of the most adaptable species for transplanting.

A seed bed 4 by 12 feet in area should be ample to produce at least 3,500 well-developed seedlings one year old (about 75 seedlings per square foot) suitable for setting out in the field or on cut-over lands.

One pound of seed (16,000 to 18,000) at this rate would be sufficient for two seed beds of this size. In case the little trees are to be transplanted when one year old to grow another year in the nursery, a pound of seed might be sowed in each seed bed and should produce not less than 6,000 seedlings at the end of the year. Such plant stock, once transplanted, is commonly hardier and is recommended over 1-year-old seedlings for particularly unfavorable locations. Ordinarily 1-year-old seedlings should prove satisfactory.

The essential points to bear in mind in raising pine seedlings in nursery seed beds are:

(a) Sow the seed broadcast, providing about 48 square feet of bed (4 by 12 feet) for each one-half pound of seed. This should produce 3,500 seedlings suitable for transplanting when one year old.

(b) Cover the seeds by sprinkling or sifting over them about one-quarter inch of fine soil.

(c) Keep the seed bed from becoming dry by applying a light mulch cover of fine leaves, pine straw, or grass (without seeds), and when necessary giving the bed a good wetting during dry weather.

(d) Afford protection against birds, mice, and other animals by screening the seed bed with woven wire.

(e) Keep out weeds.

(f) Under favorable conditions of warm weather, good soil moisture, and good seed, a germination of at least 60 per cent of slash-pine seed may be expected within the first 10 to 20 days, and the remaining germination, up to 70 per cent, soon thereafter.

Unusual care is necessary at all times to move pine and other coniferous seedlings successfully. The roots of conifers, unlike those of the hardwoods, including ordinary fruit trees, must at no time be allowed to become even partially dry. If the taproots of pine seedlings are long they should never be doubled back in the planting operation, but should be pruned to 8 to 10 inches in length and set in a vertical position. A hole of ample size should be dug; then, holding the seedling in the center at a height slightly lower than its former position in the ground, draw in the soil carefully so as to allow the roots to spread and, as fully as possible, assume their natural position. The soil should be lightly tamped with care about the roots, and it is well to add a little loose soil or leaf litter as a mulch over the surface in order to avoid injury by drying out of the soil.

A spacing of 8 by 8 feet each way (about 680 seedlings per acre) will permit of some loss of trees without too great a reduction in the resulting stand. If the situation and time of planting are unfavorable, it would be better to plant trees 6 feet apart each way, or 1,210 per acre. Slash-pine seedlings that have grown for one year in the seed bed are probably most satisfactory for field planting. Ordi-

narily 2-year-old seedlings are unnecessarily large and involve an additional cost in planting.

In the spring of 1916, 1 and 2 year old slash-pine seedlings were dug up in northern Florida and shipped by parcel post to Summerville, S. C., where they were set out. Although very late in the spring (June 2) and at the most unfavorable time for such operations, a large percentage of the seedlings lived. The Georgia College of Agriculture at Athens has had pronounced success both in growing slash-pine seedlings in seed beds and in transplanting the seedlings in the different soils of the region.

The time for planting pines in the South is preferably in the fall after active growth ceases and from then on to the spring before the buds begin to swell. After being carefully planted, pine seedlings do not require further care, except protection from fire, which is of the utmost importance. In the early fall fire lines or guards should be burned around the plantation, if there are no other means of protection, such as public roads, bodies of water, or fields. These should be wide enough to prevent fire from jumping, say from 30 to 60 yards, and may be burned out between parallel furrow strips plowed at the desired distance apart.

COLLECTING SEED.

The method used by one who has successfully collected slash-pine seed in northeastern Florida may be helpful. As soon as the cones begin to turn brown, collecting is begun, usually about September 10 to 15. The cones are picked from trees felled in logging operations and taken in burlap sacks to the man's home. They are then placed in trays made of 1 by 6 inch lumber, about 3 feet square, with bottoms screened with ordinary wire fly-screen. The trays are set on blocks to keep them off the ground, exposed fully to the sun, and covered during the night and wet weather. As the cones open up the seed are shaken out and later rubbed with a stiff brush against the screen to free the seed from the wing. They are next sifted in a coarse mesh to separate the trash and afterward are winnowed. This gives a fairly clean seed. Another method of drying and opening the cones would be to spread them out on a tight floor in a well-aired, dry building, beating or turning them to shake out the seed.

FARM FORESTRY PROFITABLE IN NEW ENGLAND AND FRANCE.

In New England, farmers are raising timber and deriving good income from their woodlands. Individual cases are numerous of owners selling 30 to 50 year old second-growth white pine on the stump at \$200 to \$400 an acre. This represents yearly gross returns mostly of \$6 to \$12 an acre.

In France, pine has been planted extensively and grown profitably on lands no more favorable than those in the South. Some 35,000 acres of sand dunes along the coast and adjacent practically worthless lands have been converted into the source of a steady and profitable turpentine business. Much of the land is now worth from \$100 to \$200 an acre.

FIRE PROTECTION.

If southern pine lands have seed trees and are protected, young growth will generally spring up in sufficient abundance for a new crop. Young pine that is afforded protection from fire grows rapidly and creates wealth. Protection of the cut-over lands from fires would mean in a relatively short time the turning of millions of acres of idle lands into profitable growing crops of turpentine and timber. To a considerable extent this would be true if fires had been less frequent or handled under control.

Fire protection, while very desirable throughout the life of slash pine, is particularly so during the first three to five years of the life of young seedlings. The rapid growth soon takes the sapling above the hottest fire zone, which occurs just above the dense grass. In this respect slash closely resembles loblolly pine, but differs widely from longleaf pine, which has a protective covering of bark, dry scales, and green leaves, fitting it to withstand fires to a remarkable degree. Although trees that have attained heights of 3 to 6 feet are injured and sometimes destroyed by slow or "cool" fires, yet a sufficient number of trees generally remain for the growth of a fair stand. Stands of pine which have not passed through repeated fires are very rare in the South.

Fire is responsible for the greater part of all damage and loss of both young growth and mature timber. Fire damages and weakens trees, making them easy prey for insects and wood-rotting fungous diseases or so-called "punks." Trees weakened by fire are easily windthrown, and this causes the loss of large amounts of pine timber (fig. 17). Millions of young pine trees, the foundation of the future forest income, are killed yearly by fire. Other millions of young saplings are defoliated and otherwise injured, resulting in stunted growth. The period of growth in which to reach merchantable sizes is thus lengthened and the financial returns decreased.

PROFITS FROM SLASH PINE STANDS.

The financial returns from second-growth pine, on the farm or small holding, are not difficult to determine if fire, the chief source of damage and loss, is absent or relatively easy of control. Under fire

prevention or control the lands are naturally restocked without expense and the timber growth is rapid. A very favorable situation



FIG. 17.—The result of repeated fires. Although “standing on only one leg” this slash pine is still living, but will likely be thrown in the next strong wind.

on many farms or plantations is that second-growth pine from 20 to 40 feet in height already occurs, frequently covering a considerable

part of the farm. If the timber is slash pine it will be merchantable for turpentine, ties, pulp wood, and firewood at ages of 20 to 30 years, yielding from 12 to 60 cords of wood per acre. Older stands, from 30 to 40 years of age, yield saw timber at the rate of 7,000 to 18,000 board feet per acre. Thus slash pine affords a choice of two sources of revenue. The value of young growth is being realized more and more as utilization includes smaller and smaller sizes of timber. Under these conditions, obviously, only a comparatively few years are required for rapid-growing kinds of trees to become merchantable.

Crude turpentine, or gum, usually sold in the standing tree, has long been looked upon in the South as a standard farm product



FIG. 18.—Slash pine boxed and worked for four years and now being worked for the second time by the better method of cupping. (South Carolina.)

(fig. 18). In Bryan County, Ga., farmers are cupping their timber and selling the gum to the local stills. After trees reach about 8 to 10 inches in diameter, cupping them for turpentine is extensively practiced. For closely grown slash-pine stands this size corresponds to ages between 20 to 30 years on good soils and 35 to 50 years on unfavorable situations. Open-grown trees reach this size at ages of 15 to 25 years. Many farmers and other small timber owners have derived a good profit from selling the turpentine rights to operators of stills for 10 cents a face or cup, for a period of three years' working. This price used to be a prevailing standard, but in 1919 it reached from 15 cents a cup on average private timber to a little over 25 cents on timber in the Florida National Forest. When carefully turpented for a period of 6 to 15 years or more, including resting intervals, and then turned into rough wood products or lumber, slash pine can be handled on short rotation or at an early age with good profit.

The recent demand for timber to be used in making ties, poles, excelsior blocks, and stavewood indicates good markets hereafter for small-sized timber. New paper-pulp mills, which require large amounts of pine of small sizes, are being established in the South in regions not covered by similar mills. The pulp wood in some instances is drawn from locations 300 miles from the mill. Lumber of smaller and poorer grades is being used each year in increasing amounts. (Fig. 19.)

EXAMPLES OF PROFIT.

Throughout the South Atlantic and Gulf Coastal Plain frequent examples are met with of profitable returns from stands of second-



FIG. 19.—Cotton, sugar cane, and slash pine—a common sight in the South.

growth slash pine. In addition to that given on page 7, a few examples are given here for further illustration.

THIRTEEN-YEAR-OLD STAND.

The slash-pine stand shown in figure 20 was turpentineed at the age of 13 years. The operation furnishes a concrete example of the commercial value of slash pine when worked at an early age, although it unquestionably would have been a better investment if the owner had waited from 7 to 12 years longer.

The stand had come up naturally on an old field in the flat, sandy pine barrens 15 miles northeast of Lake City, Fla., and conditions for growth were more favorable than on adjacent uncleared lands. It contained 628 trees per acre, of which 500 were dominant, thrifty trees of value and promise. Some of the dominant trees reached a

diameter of 10 inches, but most of them ranged from 5 to 8 inches, with a height of 40 to 50 feet. On an average, 104 trees an acre were boxed, which is an out-of-date and wasteful method of turpentineing.

For the turpentine rights for a 3-year lease the owner in 1916 received 10 cents a tree or box, or a total of \$10.40 an acre. At the present price of 20 cents a box, the privilege would have brought the owner \$20.80 an acre.

The trees when tapped contained 500 fence posts suitable for preservative treatment, and at the end of the three years' lease, allowing for reduced rate of growth, should have contained not less than 640



FIG. 20.—Thirteen-year-old slash pine stand being worked for turpentine. Unfortunately the injurious "boxing" instead of cupping method was used. There are 628 trees an acre, of which 104 trees an acre are being turpentineed, bringing the owner \$10.40 an acre and leaving 524 trees an acre for later workings. This is a profitable way of thinning and making young timber profitable. It should be understood that this stand represents probably the maximum average growth and yield.

posts worth at least $1\frac{1}{2}$ cents each in the tree, or \$9.60 an acre. The value of these posts and the gum, at the 1920 rates, gives a total gross return of \$30.40 for a period of 16 years (13 plus 3 years), or an average of \$1.90 a year. With no cost for establishing the forest stand or caring for it afterward and with very low taxes on the poor, sandy flatland, the annual net revenue, figured as low as \$1.50 to allow for compound interest on the land and taxes, represents an annual return of 15 per cent on land worth \$10 an acre—a very high figure for this kind of land.

After the boxed trees are removed, a stand of 396 trees an acre will remain. By this opening up of the formerly overcrowded stand

the trees will be stimulated to faster growth than is shown in Table 2, and, in the course of 4 to 9 years after first working, good turpentine trees, 20 to 25 years old, will be developed as large in diameter as those first worked, or larger. Calculation, based on the average past rate of growth, shows that at the age of 22 years, or six years after the end of the first working, there will be ready for the second working about 172 trees measuring 7 to 9 inches in diameter, and 152 trees 10 inches and over, a total (after deducting 10 per cent. to cover possible losses) of 292 trees an acre. Working these trees with one face per tree to high faces and assuming a price of 30 cents for each cup, the stand will bring in a second revenue of \$87.60 an acre, or a yearly average for the period of 12 years⁹ of \$7.30 an acre. The boxed timber will still be on hand, and, when sold, would add an appreciable amount to the yearly return.

TWENTY-YEAR-OLD STAND.

Reproduction of slash pine on a tract of low flatland of muck and sand soil near the town of Starke, Fla., is typical of conditions resulting from fire protection near many southern towns. The trees on this tract are mostly 21 years old, and it is reported that the ground has not been burned over in several years. The tract contains a total of 384 trees an acre of all sizes, of which 252 trees measured as much as 7 inches in diameter and over, and 55 to 65 feet in height. There are 192 trees an acre measuring 7 to 10 inches inclusive, 56 an acre with diameters of 11 to 14 inches inclusive, and 4 trees an acre 15 inches and over in diameter. If turpented according to prevailing methods,¹⁰ they would yield 316 cups per acre.

The present cordwood yield is about a maximum. The stand measured 45 cords an acre, or an average for the 21 years of about 2 cords an acre yearly. This is the equivalent of an annual yield of 300 to 600 board feet of lumber, depending on the utilization. The satisfactory growth is doubtless due to the absence of fire from the stand, for other fully stocked stands on similar situations and without fire protection at the same age, as a rule, show somewhat less production. An unburned stand as old as 20 years is rare in the South.

The value of the stand in 1920 may be taken at \$63.20 for turpentine at 20 cents a cup, and \$22 for cordwood, making a total of \$85.20 an acre. This is an average yearly return of \$3 for turpentine and \$1 for wood, or a total gross yearly return on the land of \$4 an acre,

⁹ Six years after the close of the first working plus six years of working, at the rate of 20 cents for the first face and 10 cents for the high face.

¹⁰ One cup each for trees 7 to 10 inches inclusive, 2 cups on trees 11 to 14 inches, and 3 cups on trees 15 inches and over. This, of course, represents destructive practice.

of which ordinarily four-fifths, or \$3.20 an acre, may be considered as clear profit.

TWENTY-FOUR-YEAR-OLD STAND.

An overcrowded stand of slash pine 24 years old, containing 366 trees of all sizes an acre, is now being turpentine for the third year. The trees are mostly from 50 to 60 feet tall and slow-tapering. The dominant trees range in diameter at breastheight mostly from 7 to 10 inches, with about 20 trees an acre of a size from 11 to 12 inches in diameter. This stand came up on land formerly covered by a shallow pond in Bradford County, northern Florida, and the forest growth has been repeatedly run over by light fires.

About 256 cups an acre are found on trees measuring 7 inches and over in diameter. Two cups are hung on trees 11 inches and over, and sometimes on 10-inch trees. A number of the 7 and 8 inch trees, after three years of working, have become so weakened along the gutter line by deep chipping that they have broken off. This condition, in case of a heavy fire, would result in the destruction of the faces and the killing or consuming of many trees.

The money return on this natural second-growth forest at 10 cents a cup, the price received by the owner, averaged \$25.60 an acre for turpentine. At a rate of 20 to 25 cents a cup, the revenue would amount to from \$51 to \$64 an acre for crude gum. This stand contains 126 trees an acre, 8 inches and over in diameter, large enough for common lumber. If carefully sawed, these trees would yield about 5,000 board feet of lumber, or, if cut into ties, would yield about 90 standard No. 3 size an acre. The stand now contains 30 cords of firewood or 22 cords of pulpwood (bark removed). At 50 cents a cord for firewood the timber is worth \$15 an acre standing. A fair stumpage price, or value in the tree, would be 10 cents each for ties or \$1 a cord for pulpwood. This would make the standing trees, after turpentine, worth to the owner from \$9 for tie timber to \$22 for pulpwood. The two sources of revenue—from gum (at 10 cents a cup) and ties—give the owner a gross return of \$34.60 an acre at the old price for turpentine. At a price of 20 cents a cup the two revenues would amount to over \$60 an acre. This is an approximate yearly average for 24 years of \$2.50 per acre. With taxes on this land so low as to be almost negligible, and with no cost of growing the crop, the net return may safely be placed at not less than \$2 an acre yearly.

TWENTY-SIX-YEAR-OLD STAND.

A stand of 26-year-old slash pine consisted of a total of 754 trees an acre, of which 366 measured 7 inches and over in diameter, the

customary turpentine size. Only a small number of the larger trees, from 60 to 65 feet in height, measured 10 inches in diameter on account of the crowded condition of the stand (fig. 21). This stand now contains 64 cords of wood an acre, and, if it were turpented according to the prevailing very close method of one face on trees 7 to 10 inches in diameter and of two faces on larger trees, would yield annually 366 cups an acre. If cut clean at the end of the third year of working, it would yield 67 cords of wood. These products, at the current price (1920) of 20 cents a cup and 50 cents a cord, give a stumpage value an acre of \$73.20 for turpentine and \$33.50 for cord wood. This total of \$106.70 for a period of 29 years¹¹ represents an average gross income of \$3.68 yearly.



FIG. 21.—Crowded 26-year-old stand of slash pine with 366 trees an acre measuring from 7 inches to 10 inches in diameter. Maximum production of wood—64 cords of slash pine an acre or an average growth of about 2½ cords an acre yearly. This is equivalent to over 1,000 board feet. If turpented now with only one face per tree, at 20 cents a cup the stand would yield \$73.20 an acre, and there may be expected 70 cords of wood an acre at the end of the 3-year period.

RELATED PUBLICATIONS OF THE DEPARTMENT OF AGRICULTURE.

Some of these related publications, marked with an asterisk (*), are no longer available for free distribution, but the prices at which they may be purchased are indicated. Application for free publications should be made to the Division of Publications, Department of Agriculture, Washington, D. C., and for all others to the Superintendent of Documents, Washington, D. C. Inclosures of the amount of the purchase should be made in coin or money order.

*Mechanical Properties of Wood Grown in the United States. 1917. (Department Bulletin 556.) Price 10 cents.

¹¹ Present age of 26 years with 3 years added for turpentering.

- *Relation of Light Chipping to the Commercial Yield of Naval Stores. 1911. (Forest Service Bulletin 90.) Price 10 cents.
- *Turpentine: Its Sources, Properties, Uses, Transportation, and Marketing. 1920. (Department Bulletin 898.) Price 15 cents.
- Oleoresin Production: A Microscopic Study of the Effects Produced on the Woody Tissues of Southern Pines by Different Methods of Turpentinizing. 1922. (Department Bulletin 1064.)
- Tests of the Absorption and Penetration of Coal Tar and Creosote in Longleaf Pine. 1918. (Department Bulletin 607.)
- The Southern Pine Beetle. 1921. (Farmers' Bulletin 1188.)
- How Lumber is Graded. 1920. (Department Circular 64.)
- Waste in Logging Southern Yellow Pine. 1905. (Yearbook Separate 398.)
- Making Woodlands Profitable in the Southern States. 1920. (Farmers' Bulletin 1071.)
- Production of Lumber, Lath, and Shingles in 1918. 1920. (Department Bulletin 845.)
- *Timber Depletion, Lumber Prices, Lumber Exports, and Concentration of Timber Ownership. 1920. (Report on Senate Resolution 311.) Price 25 cents.
- The Cut-over Pine Lands of the South for Beef-cattle Production. 1921. (Department Bulletin 827.)
- *Small Sawmills. 1918. (Department Bulletin 718.) Price 10 cents.
- Longleaf Pine. 1922. (Department Bulletin 1061.)

Application should be made to the various State foresters for needed information, since their publications usually apply to local conditions and are therefore very useful.

SUMMARY.

Because slash pine grows rapidly and the lumber market is fast taking lumber of smaller sizes and poorer grades, the day is rapidly approaching when good stumpage prices can be obtained for young and second-growth timber.

Slash pine grows rapidly in dense stands and, at 15 to 25 years of age, yields large amounts of crude turpentine. Concrete examples of well-stocked stands of young growth, after making liberal deductions for taxes and fire-protection costs during the period, show profits of 8 to 12 per cent compound interest on an investment of \$5 an acre.

Open-grown slash pine, on average situations, may be expected to produce in 40 years a merchantable log 40 feet long, measuring 10 inches at the top by 18 inches at the butt, and containing 270 board feet of lumber.

Land of average quality in slash pine may be expected to yield continuously a net revenue from crude turpentine or gum of 50 cents to \$1.25 an acre and an equal amount from the timber growth, or a combined yearly net return of \$1 to \$2.50 an acre.

The picture on the back cover shows a slash-pine mother seed tree, left in logging in southeastern Louisiana about 17 years before, and its 15-year-old offspring.

